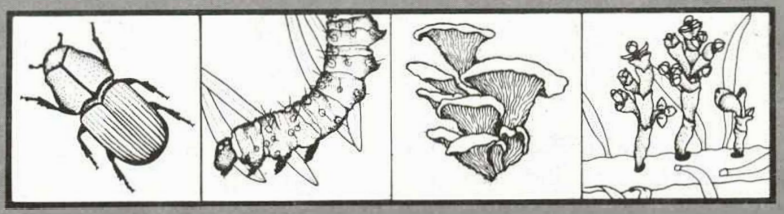
Forest Pest Management



Report 90-7

3450
February 1990

PERMANENT MOUNTAIN PINE BEETLE POPULATION TREND PLOTS: AN UPDATE, 1989

by

Kenneth E. Gibson

ABSTRACT

This report summarizes data collected from four permanent plot areas in lodgepole pine stands in northwestern Montana since 1984. Data has been collected from those areas, plus two others cut in 1983, either annually or biennially since the plots were established in 1979. Data in the current report reflect beetle status in the four areas through the 1988 flight season. Those figures show extreme beetle-caused mortality in three of the four areas: Murr Creek, Boulder Creek and Dunsire Creek. Only in the Cedar Creek (Spotted Bear) plots have beetle populations not yet reached epidemic proportions. Data indicate 54 percent, 50 percent, and 85 percent of the lodgepole pine component of the three former stands, respectively, have been killed. In the Murr Creek and Dunsire Creek plots, sufficiently few susceptible lodgepole pine remain--as a result of beetle depredations, logging or both--that those plots will not be revisited. We will continue to monitor the plots in the Boulder Creek and Cedar Creek areas. Mortality to date was compared to that predicted by the mountain pine beetle Rate of Loss Model for lodgepole pine stands. Discrepancies noted may help refine model predictions.

INTRODUCTION

In 1979, we established sets of 30, permanently marked, variable radius (BAF 10) plots in six areas in western Montana where mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (MPB) populations were beginning to build, or where outbreaks were anticipated (Gibson, et al. 1980). Annual or biennial reports updating beetle status in each area were prepared through the 1984 field season (Gibson 1981, 1982, 1983 and 1985). Though data has been collected yearly--or in some cases every other year, an interval still permitting the recording of yearly beetle activity--no reports have been written since 1985. This report will document beetle-caused mortality in the four remaining plot areas, collected since 1984 and current through the 1988 field season.

United States Department of Agriculture

Forest Service

Northern Region

P.O. Box 7669
Missoula, Montana
59807

Mortality attributable to mountain pine beetles and associated secondary bark beetles, and perhaps a change in management objectives, resulted in two of the original six areas being cut in 1983 (Gibson 1985). Now, a combination of beetle activity--again both MPB and secondary beetles (Schmitz 1989) and sanitation/ salvage of dead or threatened trees--has resulted in two additional areas being dropped. Beginning with the 1989 flight period, to be evaluated in spring 1990, we will be monitoring only the Boulder Creek and Cedar Creek areas (Figure 1, Appendix).

DISCUSSION

Having completed our observations in the Murr Creek and Dunsire Creek plots, it is of value to consider the cumulative affect of bark beetles in those areas. Table 1 shows total mortality attributable to MPB, as well as other bark beetle species in each area. While secondary bark beetle-caused tree mortality is considerably less than that caused by MPB, it is significant at times. Though not always directly related to MPB epidemics, secondary beetle populations are frequently found in concert with primary tree killers. Schmitz (1989) has found the three most common associates of MPB in lodgepole pine stands are *Pityogenes knechteli* Swaine, *Pityophthorus confertus* Swain and *Ips pini* Say. These beetles are often found infesting the tops and larger limbs of trees killed by MPB. As MPB populations decline, these beetles may attack and kill smaller diameter or weaker trees in the stand.

In the Murr Creek plots, an average 159 trees per acre were killed by MPB from 1977 through 1988. An additional 19 trees per acre have been killed by secondary bark beetles. The combined total of 178 trees per acre represent 7,340 board feet per acre volume. Though 146 green lodgepole pine, equal to or greater than 5 inches d.b.h. (diameter at breast height), remain, they represent only slightly more than 3,300 board feet volume per acre. These data indicate that while only 54 percent of the trees have been killed, nearly 70 percent of the lodgepole pine component of stand volume is standing dead, or has been salvaged (Figures 2 and 6, Appendix).

Of the 146 live lodgepole pine per acre, 5 inches d.b.h. or larger, remaining in the stand, 91 are less than 7 inches d.b.h. Only nine are larger than 9 inches d.b.h. This pattern of killing predominantly larger diameter trees first, as an epidemic develops and progresses, is well known and well documented. Outbreaks rarely occur in lodgepole pine stands where average stand diameter is less than 8 inches d.b.h. Once average stand diameter is reduced to 6 inches d.b.h. or less, there are rarely sufficient trees to maintain MPB populations. The average diameter of the live lodgepole pine component of these stands, at the present time, is 5.3 inches d.b.h.

When last visited in November 1988, plots 24, 25, 26, and 30 had been cut. Parts of others had as well. Because so many of the plots have been cut, most of the susceptible lodgepole pine has been killed, and remaining lodgepole pine is not likely to support MPB, we will not revisit those plots in the future.

At Boulder Creek, though the infestation has been slow in developing, in 1987 alone more than 54 trees per acre were killed. While slightly less than half of the lodgepole pines 5 inches d.b.h. or greater have been killed, the cumulative MPB-caused mortality, in trees per acre killed, is the second highest of the six areas. Just since 1986, an average of more than 108 trees per acre have been killed by MPB. Counting associated beetle-caused losses, 127 trees per acre, or 49.7 percent of the lodgepole pine component, are dead. More than 35 trees per acre were killed in 1988, and the level of infestation in that area appears to be declining. Average diameter of green lodgepole pine 5 inches d.b.h. or greater is just over 7 inches, and nearly 130 per acre remain. We will continue to monitor these plots for the next few years even though beetle-caused mortality has been high and at least one plot has been logged (Figures 3 and 7, Appendix).

Table 1. Yearly Mortality Recorded in Permanent Mountain Pine Beetle Population Trend Plots, 1977-1988

Permanent plot area		MPB prior to 1977	1977 attack	1978 attack	1979 attack	1980 attack	1981 attack	1982 attack	1983 attack	1984 attack	1985 attack	1986 attack	1987 attack	1988 attack
Centennial Valley	T/A[2]	4.2	9.9	13.5	47.6	6.9	5.5	0						
BLM	BF/A[3]	114.6	549.6	446.4	1,057.7	44.9	41.4	---	Cut					
Madison River	T/A	3.6	4.2	14.9	6.6	5.6	4.2	0	Cut					
Beaverhead NF	BF/A	38.3	285.1	703.6	497.3	360.1	361.2	---						
Murr Creek	T/A	2.6	2.6	4.2	3.6	9.6	7.3	7.1	21.3	6.9	16.3	36.2	25.0	16.4
Lolo NF	BF/A	68.0	47.2	113.2	45.9	112.3	287.7	631.5	1,272.2	553.6	780.0	1,652.2	976.5	268.3
Boulder Creek	T/A	0	0	0	0.6	0	0	0	0	1.4	2.5	16.1	54.7	35.4
Kootenai NF	BF/A	---	---	---	---	---	---	---	---	76.1	170.3	980.4	2,084.5	1,591.4
Dunsire Creek	T/A	0	0	0.6	0	0.5	0	0	4.1	12.4	48.7	30.7	3.9	0.7
Flathead NF	BF/A	---	---	121.6	---	53.2	---	---	370.0	1,231.1	4,691.6	2,162.5	248.7	50.7
Cedar Creek	T/A	1.1	0.3	1.0	0	0.7	0	0.5	0	0.4	0.5	0	2.6	1.3
Flathead NF	BF/A	106.6	59.4	102.1	---	46.2	---	51.3	---	59.5	55.3	---	199.1	187.5

Total MPB mortality thru 1988[1]	Secondary bark beetle mortality	Total beetle-caused mortality	Remaining green LPP ≥ 5"	% LPP killed to date
89.6	37.4	127.2	---	43.0
2,254.7	68.2	2,322.9		68.0
41.5	38.6	80.3	---	34.0
2,245.6	127.6	2,373.4		62.0
159.3	11.9	171.2	146.5	53.9
7,028.6	189.4	7,218.0	3,346.7	68.3
112.9	14.2	127.1	126.7	49.7
4,904.7	151.6	5,056.3	3,095.7	62.0
112.5	34.5	147.0	25.3	85.3
9,884.0	1,026.1	10,710.1	733.3	93.6
8.4	23.5	31.9	204.5	13.5
847.0	782.6	1,629.6	11,211.0	12.7

[1]May not equal yearly summation due to coding errors, trees missed during observations, or trees cut during the period.
[2]Trees per acre
[3]Board feet volume per acre

The 30 plots near Dunsire Creek on the Tally Lake RD, Flathead NF, have experienced the highest percent mortality of any of the six areas. Since 1983, when MPB populations began to build rapidly, more than 85 percent of the lodgepole pines, over 5 inches d.b.h., in those stands have been killed. Nearly 94 percent of the lodgepole pine volume is standing dead or has since been salvaged. In total, 112 trees per acre have been killed by MPB, another 34 per acre by secondary bark beetles. Only 25 lodgepole pine, exceeding 5 inches d.b.h. remain per acre. Most are in the 5- to 6.9-inch diameter class (Figures 4 and 8, Appendix).

The beetle infestation on that part of the Forest is essentially over--as a result of both host depletion and sanitation/salvage efforts. When plots were checked in 1988, only one tree in all 30 plots had been successfully attacked that year. It was only a "strip" attack, having been partially attacked a couple of years before. For those reasons, the Dunsire Creek plots also will not be revisited.

Finally, the lodgepole pine stands on the Spotted Bear RD, Flathead NF remain an enigma. Whereas the stands in the other five areas have all experienced severe MPB outbreaks, those near Cedar Creek in which the 30 permanent plots have been established, remain nearly unchanged. Age, stocking, growth rates and other site/stand conditions are quite similar to the other stands we have sampled. There is no apparent reason that beetle populations have not yet reached outbreak proportions in those stands. Significant beetle epidemics have occurred elsewhere on the Forest. Within the 10 years since the permanent plots were established, major outbreaks could be found as close as 30 miles to the northwest--along Hungry Horse Reservoir. Thousands of acres of lodgepole pine on the Hungry Horse RD (immediately adjacent to Spotted Bear RD) have experienced high levels of mortality attributable to MPB. Indeed, even in 1989, nearly 9,000 acres of lodgepole pine stands on the Hungry Horse RD still showed some level of infestation.

In 1987, an average 2.6 trees per acre were successfully attacked. That was the highest per acre figure in the past 10 years. In 1988, infestation intensity declined once again. In total, over the 12 years for which we have data, only slightly more than eight lodgepole pine per acre have been killed by MPB. For reasons not entirely understood, another 23 trees per acre have been killed by secondary bark beetles. More than 204 green lodgepole pine per acre, 5 inches d.b.h. or greater, remain. Of those, nearly 66 per acre are equal to or larger than 9 inches d.b.h. Average diameter of live lodgepole pine 5 inches d.b.h. or greater is 8.6 inches (Figures 5 and 9, Appendix).

Because of the perceived susceptibility of those lodgepole pine stands to MPB, we will continue to monitor them for the next few years. Annual or biennial evaluations may enable us to obtain data which will assist in refining current hazard-rating systems.

A few years after these permanent plots were established, Cole and McGregor (1983) developed a model which has become useful in predicting mortality in lodgepole pine stands subjected to MPB infestations. Based on data collected widely throughout the intermountain West, the model illustrates the effects of the beetle over a period of 10 years--the length of an "average" MPB outbreak.

Because the model was developed after the original data were collected, those data had never been subjected to its analysis. We ran data originally collected, for the four sets of plots still being monitored, through the model. With that, we were able to compare predicted 10-year mortality with what actually occurred in the same period. Results are shown in Figure 10, Appendix.

Model predictions were not as accurate as we might have supposed. Of course, no mathematical model can perfectly predict biological outcomes. In the case of the Rate of Loss Model (Cole and McGregor 1983), beetle infestation intensity can markedly affect the accuracy of model outputs.

For the Murr Creek data, the model predicted 48 trees per acre would be killed in the 10 years following 1979. In actuality, 159 trees per acre were killed (by MPB alone). In this case, the model predicted 30.4 percent of actual beetle-caused mortality.

In the Boulder Creek area, model prediction indicated 41 trees per acre would be killed. After 10 years, 113 trees per acre have been successfully attacked. Only 36.3 percent of actual mortality was predicted by the model.

Predictions for Dunsire Creek were somewhat better, but still accounted for less than half of the observed mortality. A mortality rate of 48 trees per acre was predicted; actual rate was 112 trees per acre. The result was a predicted rate 42.8 percent of that which actually occurred.

In the Cedar Creek plots, on the other hand, because beetle populations have yet to reach outbreak conditions, the model seriously over estimated 10-year mortality. Where 43 trees per acre were predicted to be killed, only eight trees per acre, in fact, have succumbed to MPB attack. In this instance, predicted mortality was five times (511 percent) that recorded.

Data from all four plot areas will be used in an attempt to refine model predictions. Should those efforts prove successful, future predictions will be more accurate, and therefore more meaningful as a tool to assist in making management decisions.

CONCLUSION

Reflecting on these 10-year observations, I have had an opportunity to consider what knowledge has been acquired from these data. I have discovered the need to be more thorough in plot design, layout and data management. Computer storage, much more readily available than in 1979, has greatly facilitated the latter. I have learned, that sometimes, despite one's best efforts, a particular data set does have limits on the amount of information to be gleaned from it. I was originally hopeful of using growth rate and phloem thickness data to refine our hazard rating system for MPB in lodgepole pine stands. That has yet to be realized. Finally, I believe I have come to conclude that we may never be able to accurately "model" every facet of a biological system, thereby "fooling all the people all the time." By 1978, we thought we knew pretty well what MPB would do in stands of certain characteristics, and when. Most of the time we weren't too far from being right--eventually.

Without being flippant, I am reminded of something I heard once, the truth of which I am only slowly comprehending. Its author is unknown; its wisdom timeless: "Under any given set of conditions, organisms behave as they damn well please!"

REFERENCES

Cole, W.E. and M.D. McGregor. 1983. Estimating the rate and amount of tree loss from mountain pine beetle infestations. USDA For. Serv., Int. For. & Range Exp. Sta., Ogden, UT. Res. Pap. INT-318. 22 p.

Gibson, K.E. 1985. Permanent mountain pine beetle population trend plots: An update, 1985. USDA For. Serv., North. Reg., CFPM, Missoula, MT. FPM Rept. 85-14. 8 p.

Gibson, K.E. 1983. Permanent mountain pine beetle population trend plots: An update, 1983. USDA For. Serv., North. Reg., CFPM, Missoula, MT. FPM Rept. 83-17. 6 p.

Gibson, K.E. 1982. Permanent mountain pine beetle population trend plots: An update, 1982. USDA For. Serv., North. Reg., CFPM, Missoula, MT. FPM Rept. 82-19. 5 p.

Gibson, K.E. 1981. Permanent mountain pine beetle population trend plots: An update, 1981. USDA For. Serv., North. Reg., S&PF, Missoula, MT. FPM Rept. 80-8, 14 p.

Schmitz, R.F. 1989. Understanding scolytid problems in lodgepole pine forests: The need for an integrated approach. *In:* Payne, T.L. and H. Saarenmaa, eds. Integrated control of scolytid beetles: Proceedings, IUFRO Working Party and XVII International Congress of Entomology Symposium; July 4, 1988; Vancouver, B.C.; Virginia Polytechnic Institute and State University, Blacksburg, VA. 231-245.

APPENDIX

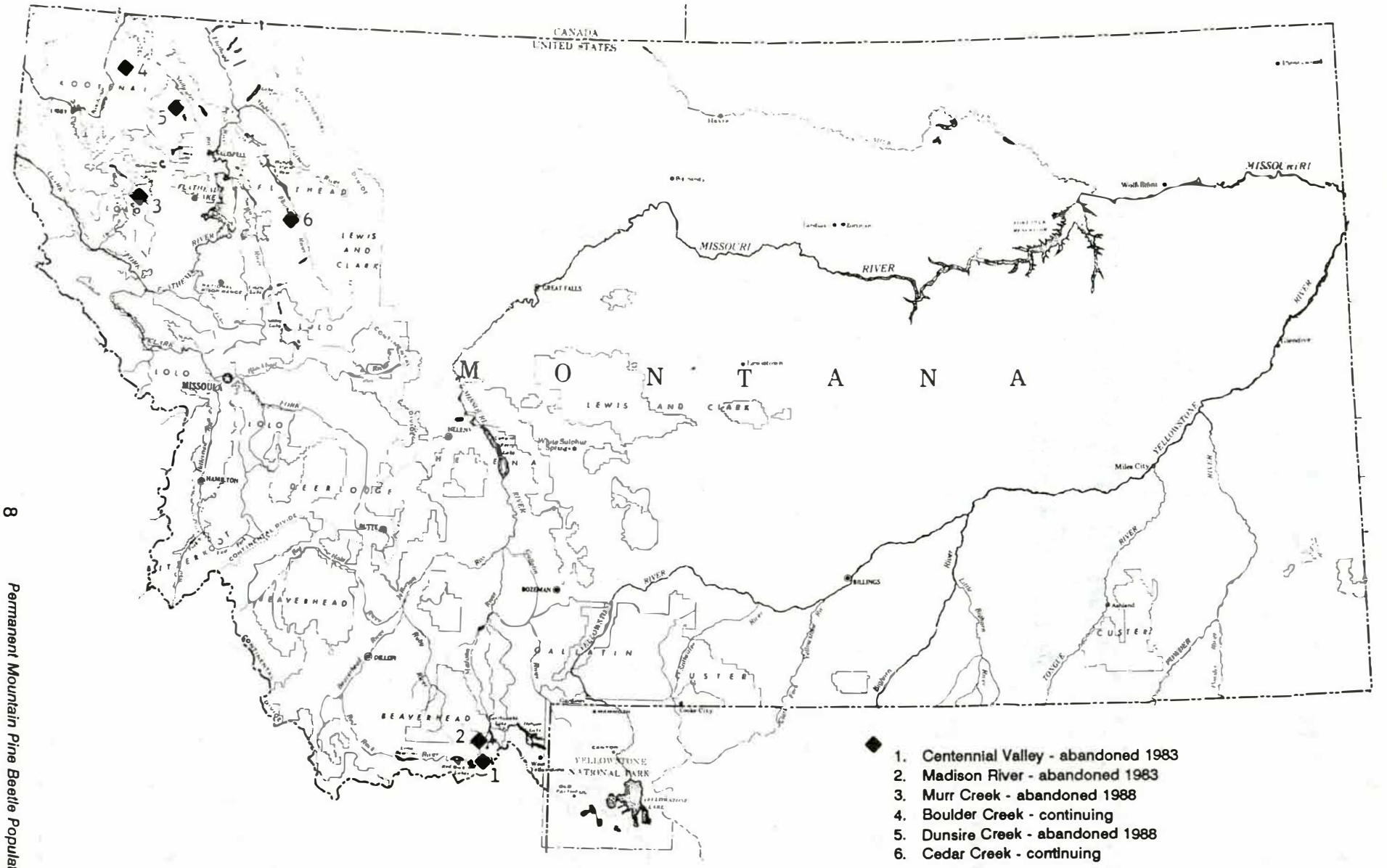


Figure 1. Permanent Mountain Pine Beetle Population Trend Plot Locations, 1979-1988.

Figure 2

MORTALITY-MPB TREND PLOTS
Murr Creek

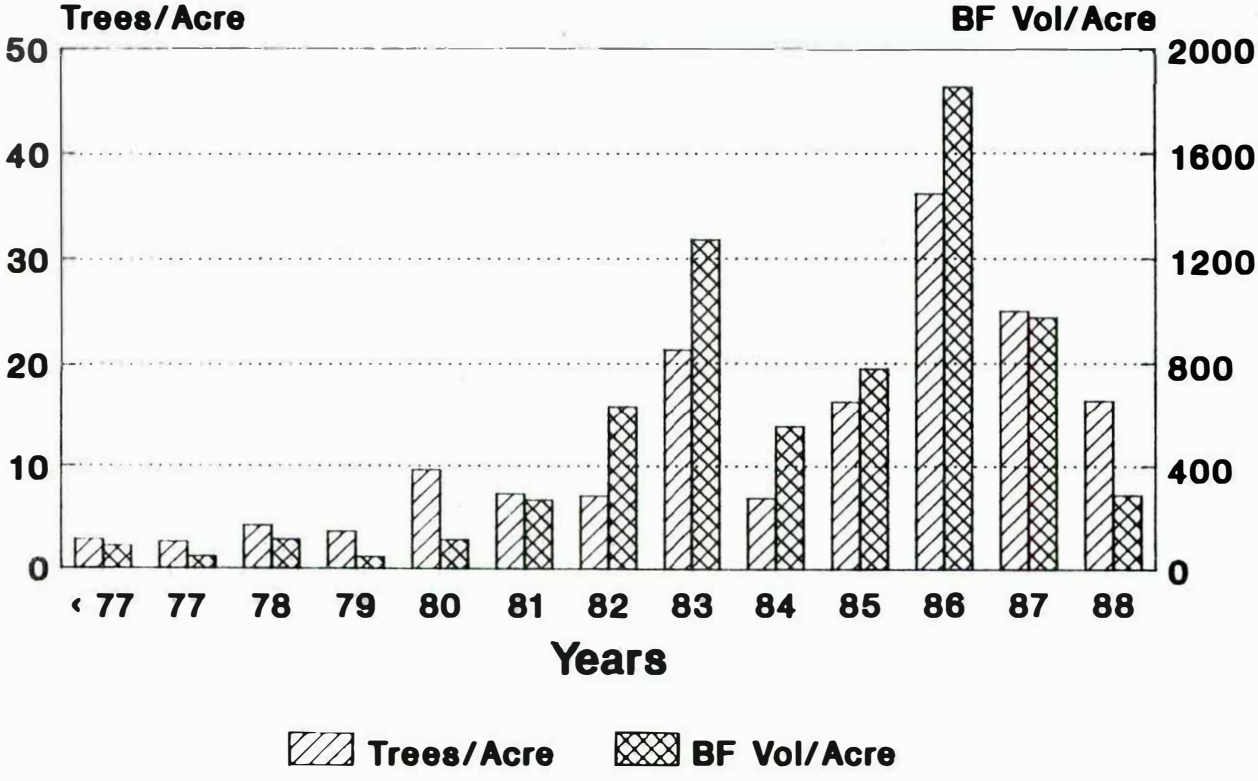


Figure 3

MORTALITY-MPB TREND PLOTS
Boulder Creek

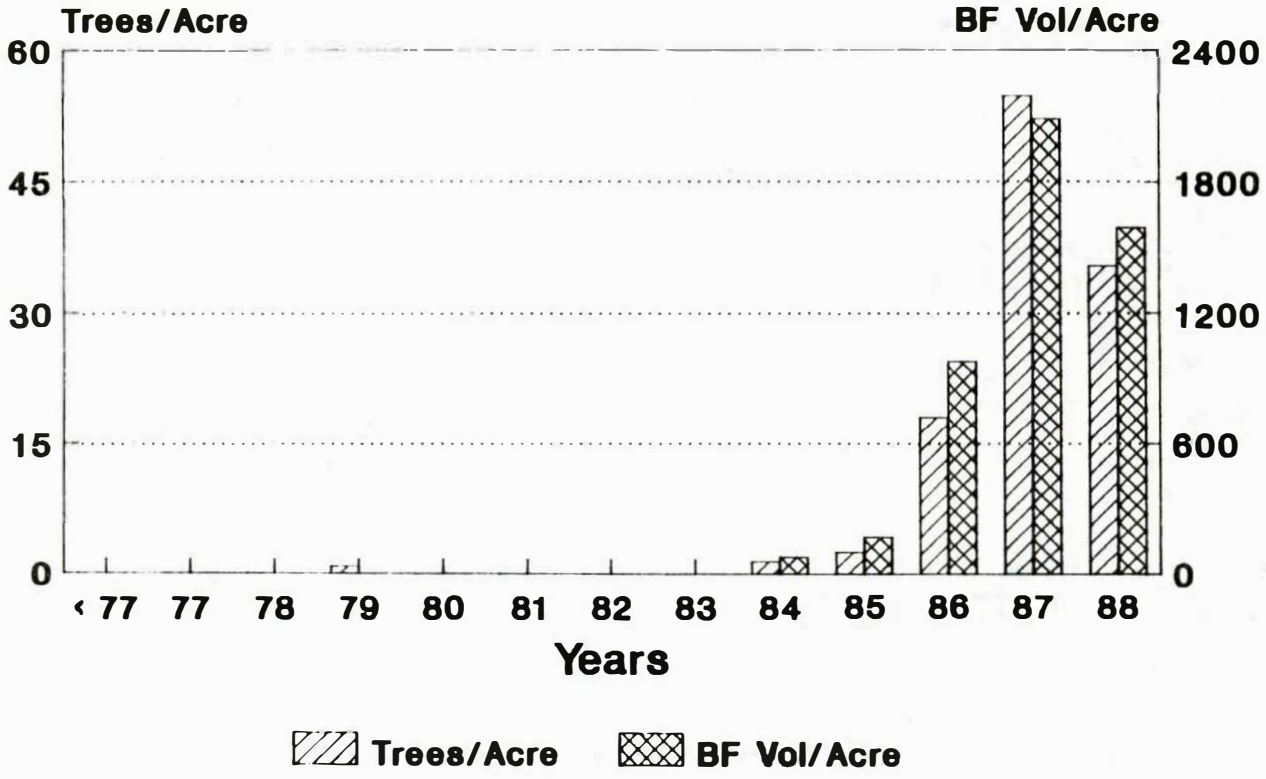


Figure 4

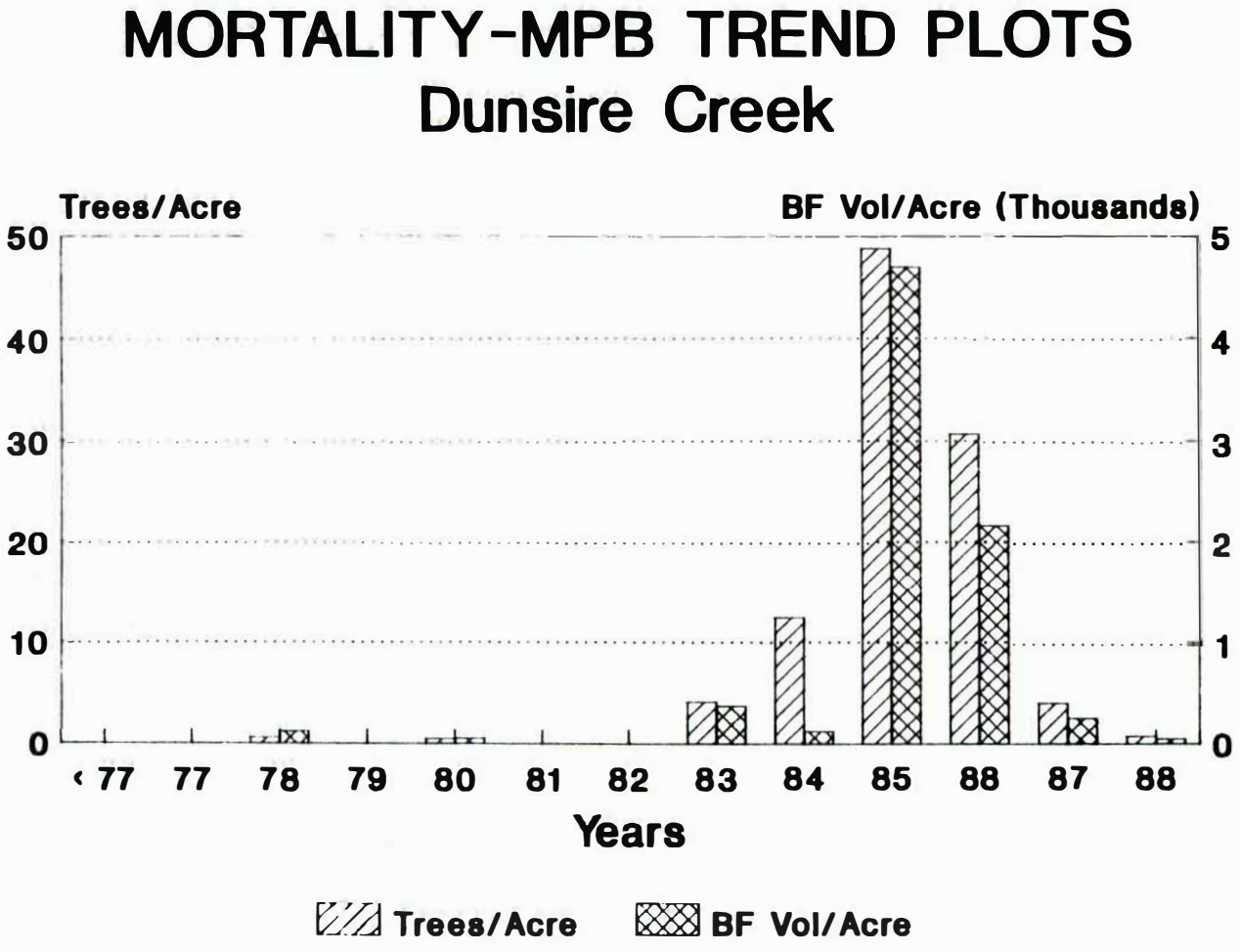

MORTALITY-MPB TREND PLOTS
Dunsire Creek
Trees/Acre
BF Vol/Acre (Thousands)
50
40
30
20
10
0
5
4
3
2
1
0
< 77
77
78
79
80
81
82
83
84
85
88
87
88
Years
Trees/Acre
BF Vol/Acre

Figure 5

MORTALITY-MPB TREND PLOTS
Cedar Creek

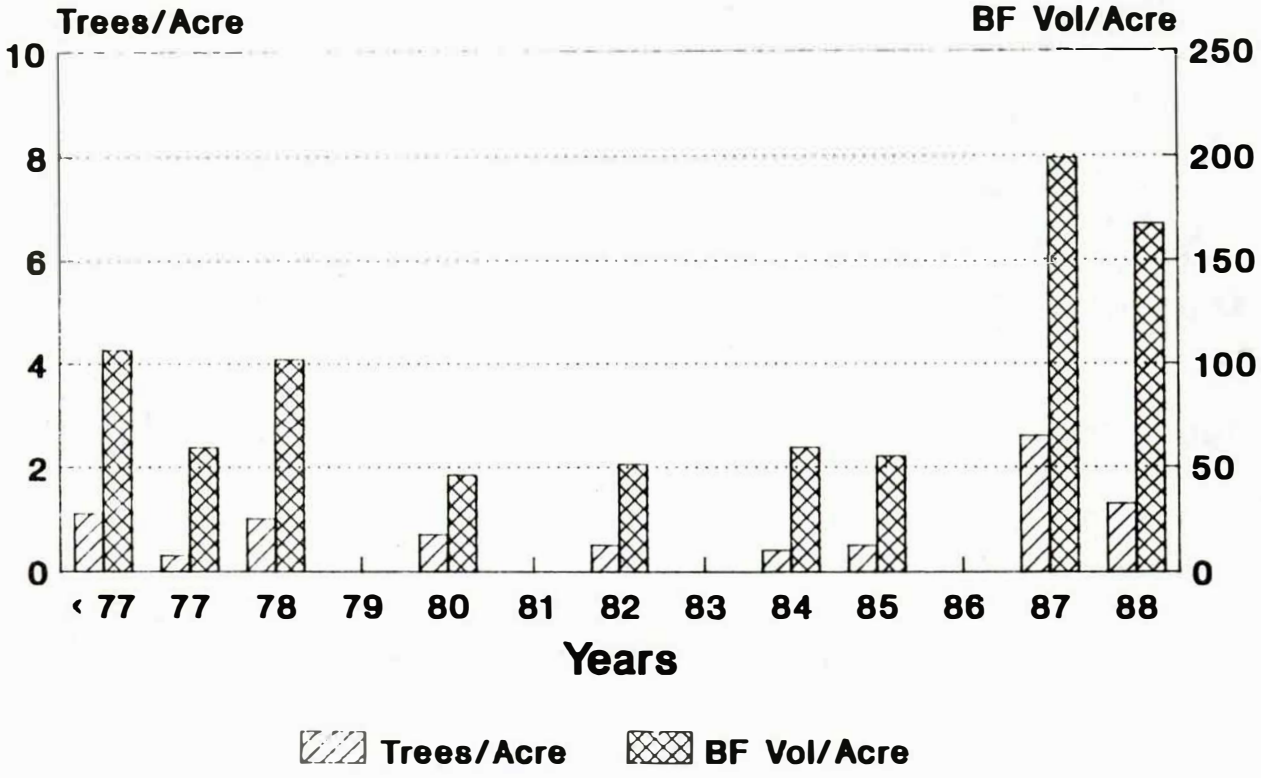


Figure 6

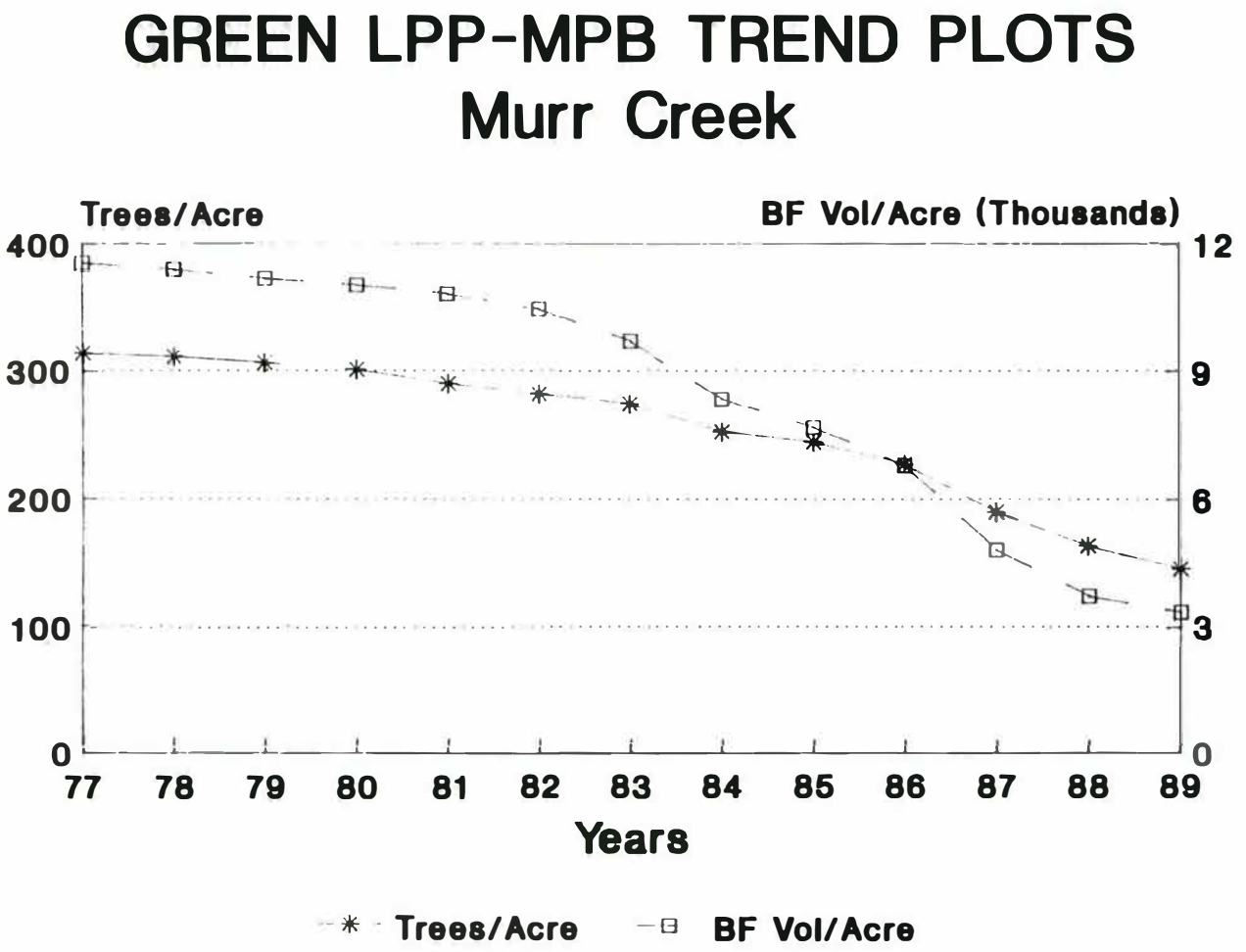

GREEN LPP-MPB TREND PLOTS
Murr Creek
Trees/Acre
BF Vol/Acre (Thousands)
400
300
200
100
0
12
9
6
3
0
77
78
79
80
81
82
83
84
85
86
87
88
89
Years
Trees/Acre
BF Vol/Acre

Figure 7

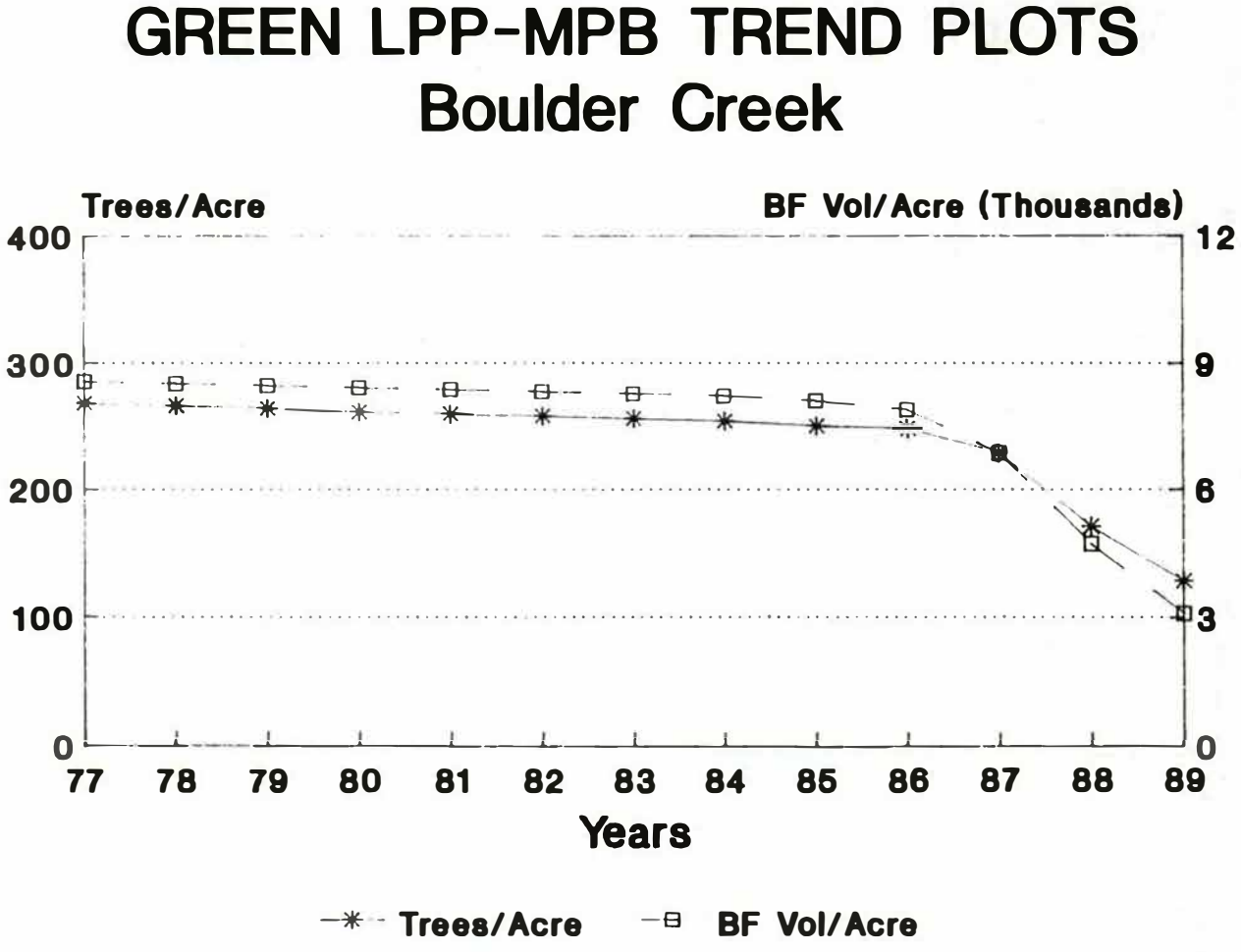

GREEN LPP-MPB TREND PLOTS
Boulder Creek
Trees/Acre
BF Vol/Acre (Thousands)
400
300
200
100
0
12
9
6
3
0
77
78
79
80
81
82
83
84
85
86
87
88
89
Years
Trees/Acre
BF Vol/Acre

Figure 8

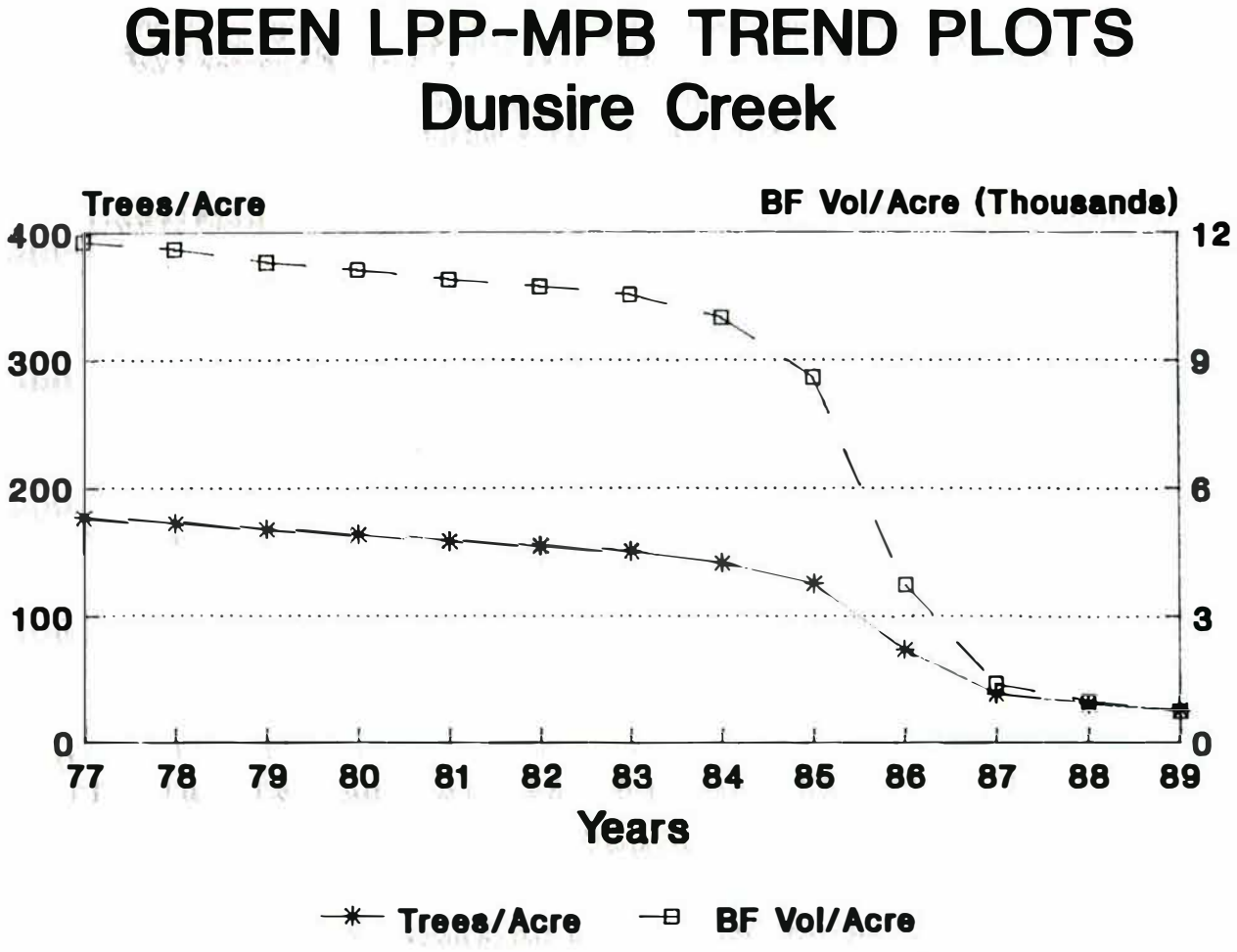
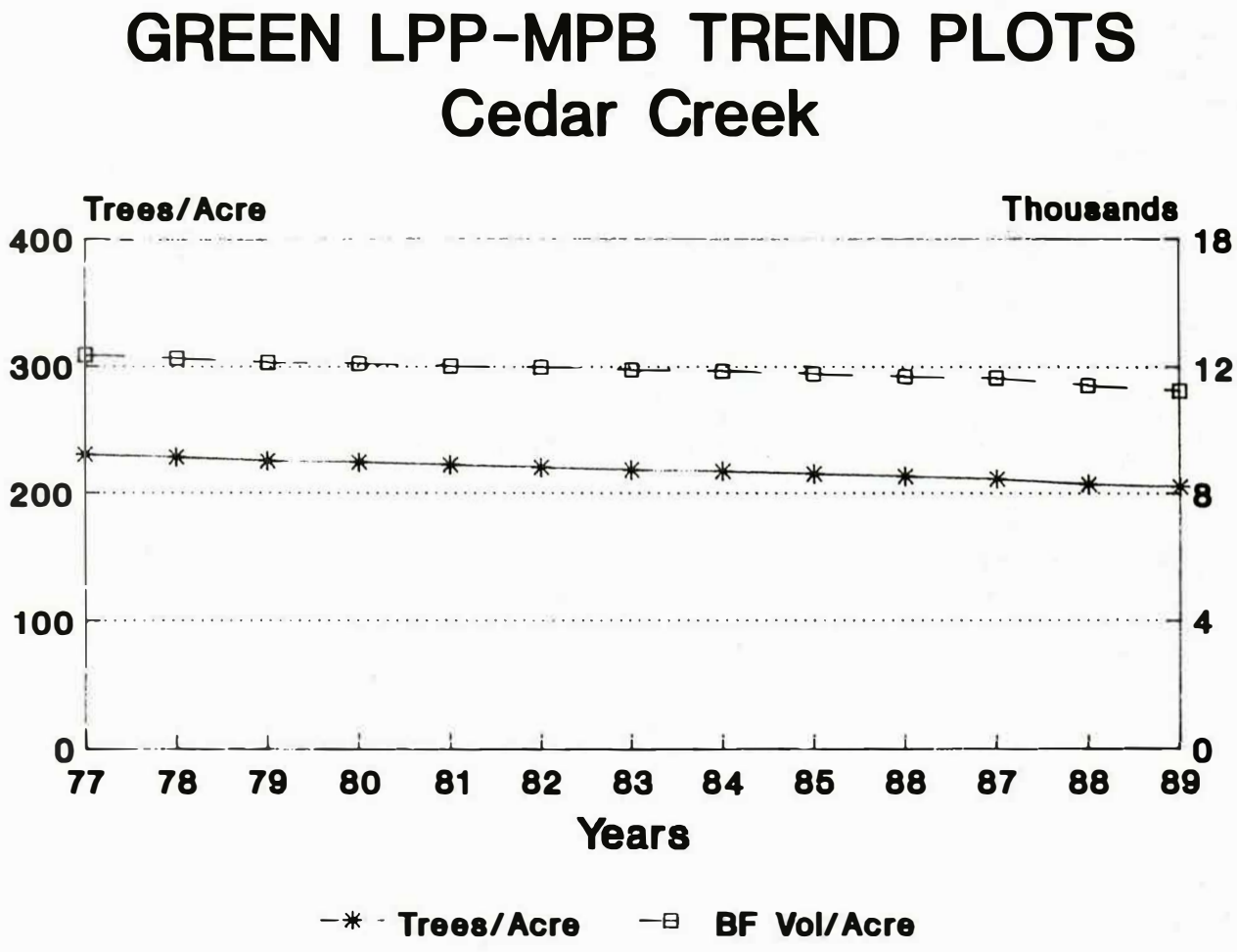

GREEN LPP-MPB TREND PLOTS
Dunsire Creek
Trees/Acre
BF Vol/Acre (Thousands)
400
300
200
100
0
12
9
6
3
0
77
78
79
80
81
82
83
84
85
86
87
88
89
Years
Trees/Acre
BF Vol/Acre

Figure 9


GREEN LPP-MPB TREND PLOTS
Cedar Creek
Trees/Acre
Thousands
400
300
200
100
0
18
12
8
4
0
77
78
79
80
81
82
83
84
85
86
87
88
89
Years
Trees/Acre
BF Vol/Acre

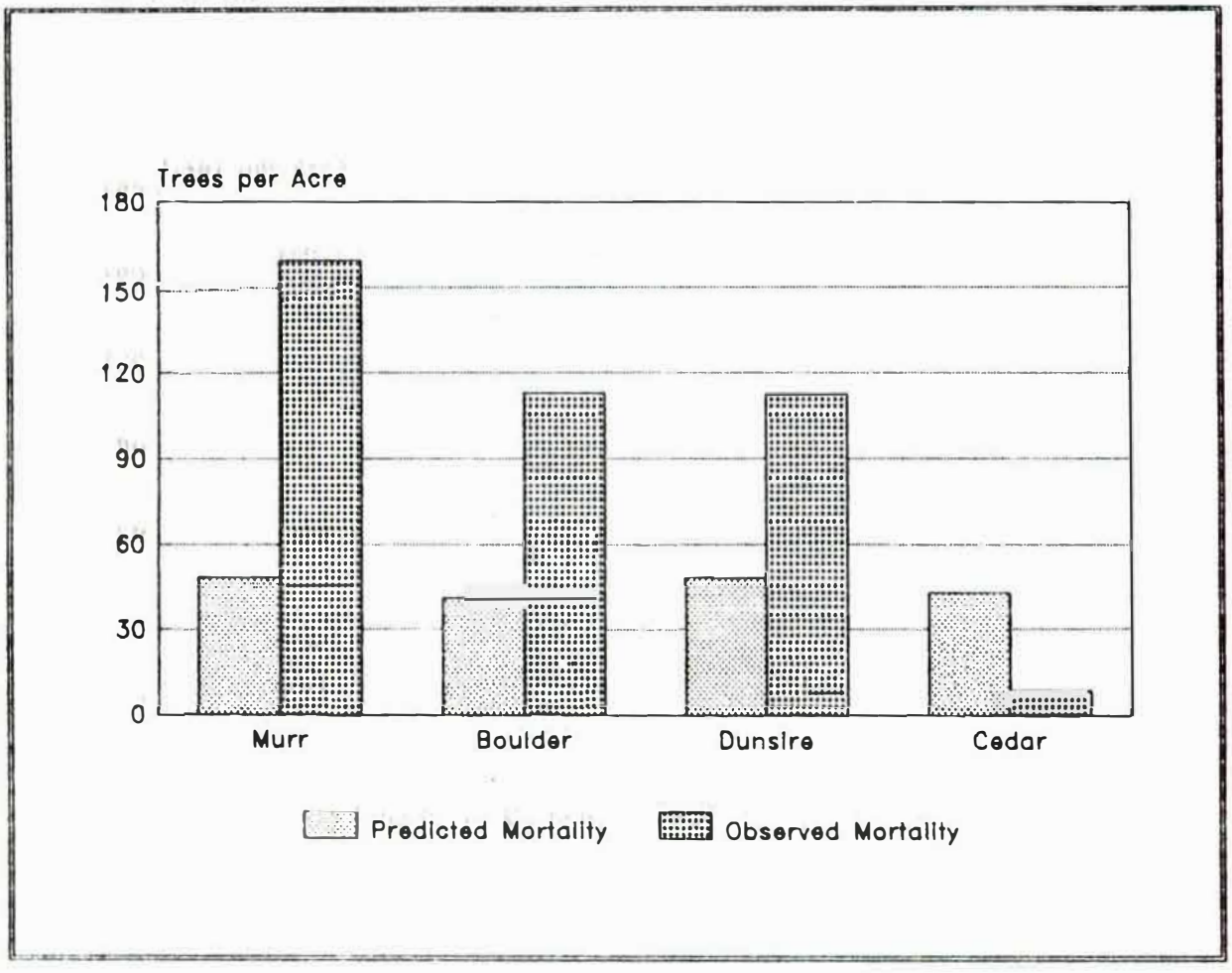


Figure 10. MPB Rate of Loss Model Predictions Compared to Observed Mortality: Permanent Mountain Pine Beetle Population Trend Plots, 1979-1988.